The evolution of Neolithic and Chalcolithic woodworking tools and the intensification of human production: axes, adzes and chisels from the Southern Levant

Abstract

Flint axes, chisels and adzes were used in the Levant for approximately 6,000 years during the Neolithic and Chalcolithic Periods. These bifacial tools went through many technological and morphological changes during this long period. 2448 bifacial tools from 24 sites were systematically analyzed, covering the final EpiPaleolithic, Pre-Pottery Neolithic, Pottery Neolithic and Chalcolithic Periods. The results indicate that radical and sometimes rapid changes took place during this time, reflecting dynamic developments in architecture, economy, social organization and modification of the natural environment.

Bifacial tools have been associated with human activity since the start of the Neolithic. They provide clear evidence of a way of life, based on intensive exploitation of the environment, which changed the balance between Humanity and Nature, and point to the evolution of more complex forms of social structure. Bifacial tools continued to be used throughout the Chalcolithic, during which time the use of metals began, social and cultural complexity increased, and the first steps towards urbanization were taken. Differences within this group of bifacial tools suggest constant improvement in tool form and function and an intensification of both the production system and resource exploitation. These patterns point to the centrality of the axe and adze as working tools and as cultural symbols. Bifacial tools were perceived as tools of efficiency, a characteristic greatly admired during the Neolithic and Chalcolithic. Changes in the bifacial tool tradition are used in reconstructing the socio-economic systems that encouraged these rapid developments, leading towards a more effective use of natural resources and the intensification of human production.
Introduction and cultural background

The axe, adze and chisel were prominent among the bifacial flint tools of the Neolithic and Chalcolithic in the Levant (about 9,600 to 3,500 cal BC). The main purpose of the research reported in this paper, is to show how they provide evidence for social conditions at that time. To achieve this, patterns in the development of technology, in morphologies and in other characteristics of the industry are viewed in the context of broader cultural, economic and social changes.

Bifacial tools are shaped by intensive flaking on both principal faces, using a technique known in the Levant since the dawn of prehistoric times (for a detailed terminology see Barkai 2002; 2005:80). An axe is defined as bifacially shaped tool with a lenticular cross section. The working edge was formed by bifacial flaking, polished, and is wider than 2cm. An adze has a plano-convex cross section. The ventral face is mostly flat and the dorsal face is curved; the cross-section is trapezoid or triangular. Its working edge is wider than 2cm. A chisel is long and narrow with a variety of cross sections. Its cutting edge rarely exceeds 2cm in width.

Lower Paleolithic Hand-axes were prominent tools in the Levant for more than a million years. About 200,000 years ago, with the appearance of the Mousterian culture, flint knappers ceased to use the bifacial technique to shape their tools. Instead, this technique was used for shaping Levallois cores. Indeed, bifacial tools are hardly found within the flint industry of the Middle Paleolithic, the Upper Paleolithic, or the Epipaleolithic periods, that is, until about 13,000 years ago.

At the end of the Pleistocene, bifacial tools were manufactured once again, this time in the framework of the Natufian lithic tool-kit (13,000–9,600 cal BC, [dates for the Natufian and Pre-Pottery Neolithic (PPN) cultures are based on Goring-Morris and Belfer-Cohen 2008; dates for the Pottery Neolithic (PN) and the Chalcolithic periods are based on Banning 2007 and Gilead 2007]). This reappearance is just one comparatively small change at a time of major changes in society that occurred during the transition from mobile food collectors and hunters to agricultural sedentary communities (Bar-yosef 1998). Early signs of this transition include orderly architecture, new forms of symbolism, common burial customs and the emergence of social complexity – all of which appear for the first time in the Natufian, and constitute the infrastructure of Neolithic societies.

The first sites large enough to be called villages are found during the first phase of the PPN period (hereafter PPNA), 9,600–8,500 cal BC. In these villages were found public buildings, such as the wall and tower of Jericho (Barkai and Liran 2008), items which suggest long-term commerce, possible cereal cultivation, artistic representations and unique burial customs. These permanent settlements, along with the introduction of plant cultivation, underlie the definition of the Neolithization process (Bar-Yosef 1995; Kuijt and Goring-Morris 2002), characterised by the introduction of the flaked flint axe, the working edge of which was shaped by transverse blows (Fig. 1). Along with flint axes, flint chisels and polished stone axes (made of basalt, limestone and other materials, Fig. 2) also begin to appear at around this time.

During the second phase of the PPN Period (hereafter PPNB, 8,500–6,400 cal BC), axes shaped by bifacial flaking and grinding/polishing (Figs. 3–4) replaced those shaped by trans-
verse flaking. While stone and basalt axes are found infrequently, polished chisels and small axes, usually made of different lithologies, begin to appear. Domestication of cereals and livestock indicate the development of an agricultural system. There was also an increase in settlement sizes, with some extending over tens of hectares. Changes in burial customs, in rituals and art can also be seen, accompanied by an architectural preference for square buildings, all reflecting profound social and political developments (Bar-Yosef 1995; Kuijt and Goring-Morris 2002; Eshed et al. 2008).

Civilizations belonging to the Pottery Neolithic Period (PN, 6,500–4,500 cal BC), are characterized by the appearance of ceramics. During this period, economic structures based on agriculture and the domestication of livestock continued to develop. Several consecutive cultures may be identified during the PN (Yarmukian; Lodian and Wadi Raba), which are significantly different in character. These differences can be seen in pottery, art, architecture and burial customs (Gopher 1995), and also in lithics, particularly in bifacial tools (Barkai and Gopher forthcoming; Gopher and Barkai forthcoming).
The flint axes that appear at the beginning of this period are similar to those of the previous period. However, by the end of the PN period, axes are replaced by adzes.

The adze became the dominant bifacial tool during the Chalcolithic, 4,500–3,500 cal BC (Fig. 5). This change in the dominant tool type coincides with the “secondary products revolution”, when milk and dairy products began to appear in the economy of the larger, better organized settlements. The Chalcolithic also sees the production of a wide variety of pottery forms, as well as accessories used for burials and rituals (Levy 1995). Flint and bifacial tools disappeared altogether after the Chalcolithic and were replaced by metal tools.
What bifacial tools were used for?

The similarities between Neolithic/Chalcolithic axes, adzes, and chisels and modern metal tools, suggests that they were used to perform tasks similar to those performed by their modern counterparts, that is, tree felling and woodworking. Using such evidence as time-on-task and muscle-use analysis, Peterson (1997) proposed significant changes in human development during the Holocene Period. For example, throwing and casting activities were well represented among the male Natufian skeletons, while females showed signs of grinding and crushing activities. Among Neolithic skeletons, Peterson also identified an increase in muscle pressure over the forearm, that is, the up-down movement. This increased activity may be related to agricultural work and tree felling (Peterson 1997). In her study of musculoskeletal stress markers in Levantine Natufian and Neolithic populations, Eshed also reported that physical stress had increased following the development of agriculture (Eshed et al. 2004). Many Natufian activities, such as hunting, gathering, woodworking and house construction, among other physical activities, continued into the Neolithic. However, some activities were completely new, such as tree felling and the building of mud-brick structures.

Use-wear analysis, ethnographic evidence and experimental archaeology strongly suggest that bifacial tools were used particularly for woodworking. Other suggested uses, including land clearance and cultivation, were not supported by use-wear analysis (Barkai and Yerkes 2003). Although used to process the same raw material, the three bifacial tool types – axes, adzes and chisels – had distinctly different uses. Moreover, it is clear that tools were deliberately created in different sizes according to the need of the time, task or place. Heavy labouring tasks were performed using large and heavy axes. For example, PPNB polished flint axes were used mainly for more difficult and heavier tasks, mainly tree felling and wood chopping (Yerkes and Bakai 2007; forthcoming). Very strong use-wear marks as well as numerous signs of damage appear on these axes, suggesting the heavy-duty nature of their use. Similar but lighter tasks were performed by using smaller axes (Haulder 1961:133; Harding and Young 1979: 105). For example, the PPNA tranchet axes, shaped by transverse blows, were used for light and delicate woodworking, which did not leave pronounced use-wear marks and which caused very little damage to the tool. These tools were used mainly for clearing undergrowth, scrub or small and thin trees (Yerkes et al. 2003).

Ethnographic evidence supports the use-wear analysis, showing the involvement of axes in a wide range of tasks (Pétrequin and Pétrequin 1993:361; Toth et al. 1992; Strathern 1969:315–319). A similar pattern can also be seen in Neolithic Scandinavia, where axes used for tree felling were also engaged in carpentry (Olausson 1982:68–69). Among certain tribes in Papua New Guinea axes are also used to cut meat, sugar canes and bamboo (Strathern 1969:315–319; Pétrequin and Pétrequin 1993:361). Semenov (1976) showed that use-wear marks appear equally on both faces of an axe, but only on one face of an adze. Ethnographic evidence and use-wear analysis both indicate that adzes were more versatile tools than the axes. All tasks performed with an axe could be completed with an adze, although the latter was also suitable for additional tasks of a more delicate and lighter nature. A study of metal axes and adzes (Salaman 1975:23) further supports the view that the adze was used for more refined work than could be achieved by using an axe; these included the leveling, shaping or smoothing of wooden planks.

Semenov concluded that adzes were used mainly for woodworking. He rejected the suggestion that they were also used for land clearance and cultivation. Such work would have damaged the adze severely (Semenov 1976: 124–125, 129–133). Ethnographical evidence supports Semenov’s view. Similar to axes, adzes are used for tree felling, construction, shaping wooden utensils and bone processing. However, they were also used for more delicate tasks, such as carving and the manufacture of fibres and threads (Townsend 1969:200; Cranstone 1971:133; Toth et al. 1992; Pétrequin and Pétrequin 1993:361). Chisels, which are normally smaller than axes or adzes, were commonly used for more delicate woodworking, rather than heavy work (Becker 1962). Anthropological evidence suggests yet another, quite extraordinary, use of adzes. Graves associated with some Neolithic sites in Germany, contained skeletons whose skulls have been smashed. A study of the skull fracture patterns suggested that these skulls were smashed by use of stone adzes or other bifacial tools (Keef er 1993:108–109; Teschler-Nicola et al. 1996; Wind 1996). In sum, the Neolithic toolkit included different types of bifacial tools, of different size and weight, which were suited, amongst other things, to many different kinds of woodworking; from the most massive tasks to the most delicate ones.
Use-wear studies of bifacial tools from the southern Levant are scarce. Keeley examined two trancheet axes from Jericho and concluded these were hafted as adzes and used for woodworking (Keeley 1983:759). Yerkes has examined samples from four sites belonging to the PPNA, PN and the Chalcolithic Periods. All of these use-wear analyses indicate that bifacial tools were typically used for woodworking, although some tools were also used to process bone, hide, meat, and plant material. These studies confirmed that chisels were used to complete lighter tasks than axes or adzes. Use-wear analysis also supports ethnographic evidence that adzes were far more versatile tools than axes, demonstrated by the different extent and depth of use-wear marks found on the two tool types (Barkai and Yerkes 2007).

The dual role of bifacial tools as working tools and symbols

The connection between the (re-)appearance of bifacial tools and the transition from nomadic hunting and gathering to settled agriculture is not incidental. Bifacial tools were developed as a solution to a practical problem; they played an important role in the life of early settlers. The Neolithic axe was an essential and significant tool, used for most important daily activities. Typically, these included the clearance, construction and carpentry (Barkai and Yerkes 2007; Drobniewich 1988; Keeley 1983; Juel Jensen 1988; Olausson 1982; Yerkes et al. 2003; Yerkes and Barkai 2004; forthcoming). Since the axe was in essential and constant use, it had to change frequently, adjusting to new needs, construction methods and other changes (Pétrequin 1993:52–5). Therefore, changes in the form and use of bifacial tools during the Neolithic and Chalcolithic most likely reflect wider material/cultural changes. The transition from temporary to permanent settlement is accompanied by the appearance of architecture which integrates timber beams and poles. The transition to agriculture required tree felling and the clearing of agricultural fields from previously forested areas. Domestication of livestock required animal pens and wooden fences. These tasks required the procurement and use of natural resources on a substantially greater scale than at any time previously.

Bifacial tools were much more than simply a solution to a technological problem. Beyond (and sometimes because of) their practical roles, they could also hold a profound social significance, drawn upon in the construction of ideas about identity and in the negotiation of relationships (e.g. Steensberg 1980:4; Battaglia 1990:78, 133–4; Taçon 1991:204–205; Patton 1991a:67, 69; Pétrequin and Pétrequin 1993:368; Thomas and Tilley 1993: 293, 309; Tilley 1996:322, 324). Implicated in the construction of ideas about age, gender and status, the Neolithic axe seems to have been a central cultural symbol, related to different spheres of human existence. In addition to its basic function, it had a value linked to the creation of relationships through both daily activities and special rituals (e.g. Tilley 1996:14).

There are echoes of these associations in ethnography. Among the Dani in Western Papua, for example, the axe is an essential part of existence. Agriculture is not sustainable without axes, and the axe is the central tool which enables the Dani to exploit nature. The axe has been used both as a working tool and as a ceremonial tool longer than any other (Pétrequin and Pétrequin 1993:359–361). Axes and similar tools have also attracted other meanings. In Melanesia, they are perceived as beneficial as they add grease to food. The axe is presumed to speed recovery and health, and a stone axe may be given to sick children in the belief that it will aid recovery. Some Melanesians consider the axe as the substance of life itself; representing the physical being of humans, and significant as a medium that transfers messages concerning reproduction. It is even called by a name which means “phallus” as well as “right hand”. Its blade represents the potential of Man’s reproduction, symbolizing the male reproduction energy. These connotations provide the axe not only with its spiritual value, but also its considerable economic value. Thus, symbolically, the axe is related to the production of new people and new artifacts (Battaglia 1990:78, 133–4). Among Aborigines in Australia, axes symbolize masculinity and the coming of age. The symbolic meaning of the axe is related to the powers that shaped the landscape, so much so that the sources of the raw materials required to make them are often perceived as having a direct and powerful connection with specific ancestral spirits or dreamtime beings (Taçon 1991:194–5).

The characteristics of Neolithic and Chalcolithic bifacial tools

Important changes in the forms of axes, adzes, and chisels took place between the PPNA and the Chalcolithic. These changes can be studied in a number of ways, but a useful starting point
is the calculation of their Frequency of Occurrence. In order to calculate the overall frequency of occurrence for all bifacial tool types during each period (Barkai 2005:289), the frequency of occurrence for each of the three major bifacial tool types was calculated in relation to the total of bifacial tools from each site. Then, for each period and culture, the average frequency of occurrence and standard deviation statistics were calculated. Bifacial tools of the Natufian and Lodian (Jericho IX) Cultures were not included in this analysis, either because they are not directly comparable, or because of a lack of adequate sample assemblages. Each point in Figure 6 represents the range and average value of the specified tool type. The vertical lines represent the standard deviation for each marked average. The continuous lines have no meaning other than to connect the averages for each tool.

While the PPN and the Chalcolithic Periods seem to be rather stable in their characteristic tool types, the PN seems to be a very dynamic period of change and transition. It is clear that a single type of bifacial tool was dominant at almost any specific time, accounting for a half to two thirds of all bifacial tools. Axes predominated in the PPN cultures but declined dramatically in relative frequency over the course of the PN period. This fall was matched by a rise in the proportion of adzes. During both the PPN and the early part of the PN, chisels show a stable, though infrequent, profile among the bifacial tools. Over the course of the PN, however, and in particular during the period of the Wadi Raba Culture, they become far more frequent. The Chalcolithic is marked by the dominance of adzes, which comprised two thirds of the total number of bifacial tools, and the restoration in the relative importance of chisels.

These changing frequencies are valuable. But they only give us part of the picture, and are best set against broader patterns of tool making, tool use and symbolism as they unfolded between the Natufian and the Chalcolithic.

**Natufian Bifacial Tools**

Natufian bifacial tools lack uniformity, clear prototypes, or sufficiently clear diagnostic morphological features. The bifacial flaking technique was usually applied only partially, and was not even used to reduce the tools’ volume. Most typically, their flaking is coarse and careless, and it is not possible to identify key variables in the quality in the manufacturing or shaping processes (Barkai 2005:367). Knowledge about the tasks performed using Natufian bifacial tools is scant. By their nature, such tools appear to have been designed to perform a different range of tasks when compared with the bifacial tools from later periods. Judged by their form and size, it seems that the Natufian bifacial tools were ill-suited for woodworking. While the functional purposes of the earliest bifacial tools remains unclear, it is probable that they had a symbolic role from the outset. For example, at Hayonim Cave, bifacial tools coated with ochre were hoarded in graves, and especially those of men (Belfer-Cohen 1988), indicating these tools had a ritual value.

**PPNA Bifacial Tools**

The PPNA marks the end of microlith-based industries and the rise to dominance of arrowheads, sickle blades and bifacial tools. These changes mirrored others. Axes shaped by transverse blows had a universal appeal to many societies at the start of the Neolithic, an appeal evidenced by their widespread and frequent occurrence. However, this did not last long, and they were quickly displaced by polished axes. It seems that the newly emerging Neolithic way of life brought with it new challenges that triggered a similar solution to similar problems world wide (Barkai 2005: 12). The production of PPNA axes and chisels required access to essential good-quality materials, and the necessary skills to fashion them into effective tools. Such requirements led to the creation of axe
workshops. These workshops were not only centres of manufacture, but also of distribution, repair and maintenance (Barkai 2001). However, manufacturing and maintenance activities were also carried out on a smaller scale within residential sites.

Flint axes shaped by transverse flaking are very light-weight, thin and narrow. Weighing on average less than 40gm each and with a typical thickness of 15mm, these small tools could not have been used for tasks requiring much force. In fact, their measurements, and the resulting possible tasks which they fulfilled, place these axes in a separate group when compared to the standard category of axes. It is probable that these less robust axes were used for cutting shrubbery or perhaps small trees, and for light woodworking tasks (Yerkes et al. 2003). Curiously enough, these small axes disappeared with the transition from circular structures (typical of the PPNA) to square structures as the dominant architectural form. No truly heavy duty tools, with which the environment could be remodeled, were found in the PPNA.

Polished stone axes were contemporaneous with the flint axes and chisels. These differ from flint tools in many ways, including raw material, quantity, shaping techniques, archeological context and state of preservation. Polished stone axes were often made from limestone and basalt, and were shaped by pecking and polishing. The matching of specific manufacturing techniques to particular lithologies and tool types was also possible. For example, no flint axes were polished; and no stone axes were shaped using transverse flaking techniques. While flint axes were used for daily tasks, polished stone axes appeared to have served a more symbolic purpose. They were made to be conspicuous: long, thick, and heavy (Yerkes et al. 2003). They are typically found whole and undamaged. They were probably used as talismans, symbols of status, or valuable personal possessions (e.g. Skeates 1995).

The PPNA polished flint axe is striking not only because of its relatively large size, but also for combining two previously unconnected features: polishing and flint. Extending the arguably ritualistic practice of polishing to evidently functional flint axes was highly significant. Polishing made flint axes stronger and more durable in use than their unpolished counterparts (Barkai 2005:18). Not only that, it brought out qualities in the form and appearance of axes which added to the esteem in which they were held. As noted above, it is also significant that these changes in approaches to stone happened at a time that saw shifts from the oval structures of the PPNA to the more rectangular buildings of the PPNB.

This new type of axe, the polished flint axe, became the dominant type among the PPNB bifacial tools. These were used for sustained heavy work such as tree felling (Barkai and Yerkes 2007). Of course, not all polished flint axes were large enough to perform these tasks; and it is likely that smaller examples replaced the more traditional uses performed previously by the more delicate transverse flaked axes. During the PPNB then, human control over the environment took on new characteristics, driven, in no small part, by the shift to new methods of building construction. The floors of PPNB rectangular structures were constructed using massive wooden posts, up to 60cm in diameter, set in equally massive post holes. At the site of ‘Ain Ghazal, for example, rectangular single room structures covered areas of c.35–50m². It has been estimated that each house of this type used c.10 wooden posts to support the walls and ceiling (Rollefson 1997; Rollefson and Kohler-Rollefson 1989, 1990).

The PPNB saw some of the most profound changes associated with the Neolithic, among them an increased emphasis upon domesticated plants and animals and the dramatic modification of local environments. As the principal tools used in woodworking, bifacial
tools played a central role in this process. Woodworking was required in all areas of life; the construction of storage and living domains, the building of pens and other enclosures. Wood was also a fuel in the manufacture of lime plaster, which had many uses during the PPNB; covering floors, walls and graves, the plastering of skulls, and the preparation of sculpture and beads. Wood reserves were exploited extensively during the PPNB, in some cases perhaps to the point of exhaustion. By the final stages of the PPNB (the PPNC) architectonic trends suggest that this may have been a concern. Wooden posts gradually disappeared, or were reduced in diameter (Rollefson 1997:288–303; Rollefson and Kohler-Rollefson 1989:81). Plaster also declined as a widely used material. Instead, walls were used to support structures, and mud floors became more popular.

The PPNB saw the production of a new type of axe, stronger and more durable, which was capable of meeting new construction requirements. Undoubtedly, use of wood reached new levels during the PPNB. The increase in scale was dramatic, so much so that it may have brought about an environmental crisis that led to an alteration of global climate (Ruddiman 2003, 2005; Ruddiman et al. 2008). Even if such a crisis did not happen, the relationship between Humanity and the Environment was certainly redefined at this time. Communities were modifying their natural environments in ways that could not be ignored. And it was in this pursuit of power, economic prosperity, and social development, that bifacial tools played such important roles – as both functional tools and as symbols.

PN Yarmukian Bifacial Tools
The start of the earliest culture of the PN, the Yarmukian culture, was marked by the appearance of a new tool type: the adze. A few adzes have been recognized from the PPNB, but within the Yarmukian toolkit, adzes became much more common, typically accounting for c.10% of all bifacial tools. As during the PPN, axes and chisels continued to dominate the group, but the axe’s supremacy was now challenged by the chisel. Early in the PN, chisels comprised c.15% of all bifacial tools, reducing the overall proportion of axes from almost total to around 40%. The acceptance of the chisel as a third bifacial tool type, marked the start of a decline in the central importance of the axe, which eventually led to the adze becoming the dominant bifacial tool.

Whatever its causes, the decline in the need for heavy woodworking and tree felling, saw axes give way to more versatile adzes. These were used in similar ways to axes and, despite a tendency to be lighter and more narrow, broadly resembled them in size and weight (Barkai 2005:293–335). The manufacturing and shaping processes of both axes and adzes were similar, with the exception of blank selection. Thus, the adze could have easily found its way into the existing familiar system. However, adzes and axes differed in their hafting methods. This was significant because it affected not only the length and cross section of the tools, but also, and perhaps more importantly, methods of use. The adze, hafted like a hoe, was adequate for far more tasks than the axe. Adzes were used for anything from felling massive tress to chopping to the preparation of wooden utensils (Barkai and Yerkes 2007). The axe, in contrast, was inadequate for such delicate tasks. Looked at in long term perspective, it seems almost as if the adze was “on probation” during the Yarmukian culture. Until it had proved its worth, its supremacy could not be accepted, and therefore, the transition from axe and chisel, to adze, was gradual.

Although PN architectural trends turned away from the use of wood as the primary construction material, it was still used for roofing, and probably also for pens and other enclosures. Wood was no longer used as fuel for plaster making, but did see use in this way in the emerging pottery industry. The appearance of ceramics was the most significant cultural change of the period, and underlies the definitions of PPN and PN cultures. This significant change is also evident in the new trends found among the bifacial tools. It could be that the use of stone tools for cutting wood as fuel for plaster manufacture differed significantly from the cutting of wood designated for use as a fuel for firing pottery. Perhaps the versatility of adzes was better suited to the firing of pottery. Or perhaps, this new tool was adopted by the growing pottery industry as a new symbol for a new way of life. Whichever the case, the relationship between the adze and the pottery industry becomes stronger over time, as both the dominance of the adze, and the pottery industry characterise the Chalcolithic.

PN Lodian Bifacial Tools
No Lodian assemblages were analyzed during this study due to the scarcity of bifacial tools in any of these assemblages. However, with the recent publication of two Lodian flint assemblages (Gopher and Blockman 2004; Kahlaily 1999), it seems that bifacial tools were not used excessively in the Lodian culture. The Lodian
culture did not make much use of wood as fuel for its pottery industry. Lodian pottery used bright clay, hay, and organic tempers. The tools were made by hand, not on a potters’ wheel, and the firing was done in low temperatures (Gopher and Blockman 2004; Gopher and Gophna 1993). It is possible, then, that the decreased demand for wood caused, in turn, a decrease in demand for bifacial tools.

Lodian bifacial tools were not the only flint tools that portray unusual characteristics. The Lodian culture ceased to use both the naviform technology for the production of blades and the large arrowheads that had been common up to this point. The Lodian culture also saw new technologies, among them the making of sickles from a variety of blanks via pressure flaking (Gopher and Gophna 1993). These changes,
which are significant, may represent changes in daily routines or in their execution, for example: harvesting, hunting, and woodworking. The changing blades and sickle blades may indicate new harvesting methods or less intensive harvesting; the disappearance of large arrowheads may be related to the growing reliance on domesticated animals and the gradual secession of hunting.

**PN Wadi Raba Bifacial Tools**

The transition from axe to adze reached a climax during the Wadi Raba culture, which saw the axe reduced to only about 10% of all bifacial tools. Both adzes and chisels reached a level of popularity previously unknown, each constituting about one third of all bifacial tools. The chisel remained the most stable form throughout the PN (Fig. 7). That said, some morphological changes can be detected, which suggest a close practical and perhaps conceptual link with adzes. While Yarmukian chisels and their predecessors have lenticular lengths and cross sections, as do axes, Wadi Raba chisels more closely resemble adzes, with their plano-convex length and cross sections. As this characteristic is pertinent to the hafting of the tool, it seems that chisels were adapted to the trends of the time. Demand for heavy woodworking tools continued to decline during the Wadi Raba culture, and adzes were used more frequently for lighter work, as were chisels (Yerkes and Barkai forthcoming). These changes also happened alongside others; in the composition of flint and ceramic assemblages and in architectural traditions. Flint sickles become rectangular and more finely denticulated, and arrowheads seem to disappear altogether, changes which suggest a final, significant, decline in the economic and social importance of hunting.

The decline of hunting as a primary economic factor heralded a new order, based on new and increasingly consolidated means of production. As part of this change, it seems that gender relations were also affected, determining new labour relations, and perhaps defining gender-specific roles and responsibilities (Naveh and Gopher forthcoming). Changes occurring throughout the PN were closely related to the economic transition to a system based entirely on agriculture. These changes encompassed all areas of life, including the introduction of new manufacturing techniques, and a new social order. The institutionalization of the means of production and reproduction were essential to ensure the survival and continuation of societies. Throughout this process, bifacial tools provide a barometer of change.

**Chalcolithic Bifacial Tools**

The adze was the dominant bifacial tool during the Chalcolithic. Chisels also continued in use, but by this time, axes had almost entirely disappeared. The increasing demand for adzes also brought about changes in the choice of raw material, involving decreases in both the quality and suitability of the rocks used, a trend that went hand in hand with the increasing use of locally available materials. Certainly, such a change affected the whole industrial system established as early as the PPNA. With the falling away of traditions of mining or quarrying at specific sources and the increased reliance on material procured with little effort or formality, manufacturing became a feature of life on many settlements. This, in turn, brought about changes in performance. The reduction in quality of the rock used to make most adzes meant that they broke far more frequently, a tendency evidenced in many Chalcolithic assemblages.

The dual role of the axe, as functional tool and cultural symbol, was now transferred to the adze, which became an important cultural marker at this time. Whole undamaged polished adzes were placed with some formality in magnificent burial complexes, such as Peqi’in Cave, clear evidence that they had taken on a role as important markers of standing. The Chalcolithic also saw other shifts of practice, amongst them a falling away of the traditional distinction between adzes that were used and those that played an essentially symbolic role. It was context that determined the significance of an adze, and it may well be that associations, with people or tasks, acquired during use, may have increasingly been a part of that significance at this time. There are also hints that adzes were sometimes reworked as part of the process of according them symbolic significance. At Peqi’in for example, parts of the polished surface of certain adzes were deliberately removed prior to their incorporation in formal deposits (Barkai 2005:268).

During the Chalcolithic, adzes were extensively used for woodworking. However, as bifacial stone tools from only a single Chalcolithic site were analyzed for use-wear marks (Yerkes and Barkai 2004), it is possible (although unlikely) that these tools, hafted as hoes, were also used in a similar way to cultivate the land. If indeed any adze was used for agricultural purposes, it must have most certainly been damaged to an extent that could no longer function as a woodworking tool. Thus, adzes deemed unfit for woodworking were most likely used as hoes, and this would have certainly been the last stage in their life cycle.
Still important for woodworking, in the provision of fuel for pottery production and in various kinds of construction, adzes were most likely also engaged in new tasks that emerged during the Chalcolithic. These included work around the management of new resources, such as fruit trees (mainly dates and olives), and perhaps even the processing of secondary products. Fuel was also needed to fire the working of copper and gold, which became increasingly important over the course of the period. These broader economic changes hint at an intensification and diversification of production, which seems to have gone hand in hand with other developments, such as the emergence of settlement hierarchies and the appearance of formal cemeteries outside residential areas. These changes suggest that the period saw the emergence of Chiefdoms – complex hierarchies sustained by control over various kinds of production, and over the circulation of important materials, among them metalwork. The metal industries changed social and economic values and priorities and from the very first, copper axes, adzes, and chisels appeared both as working tools and as ritualistic objects. However, bifacial stone tools continued to hold their value as both practical and symbolic items throughout much of the period.

Despite occasional attempts at replacement by metal artefacts, bifacial stone tools continued to hold their value as both practical and symbolic items throughout much of the Chalcolithic (Shalev 1992). Various factors may have influenced this situation, among them the scarcity of the technical knowledge and/or resources need to produce metal tools (e.g. Goren 2008). By the end of the period however, the situation had changed, the use of stone adzes, chisels and axes effectively ceased. This abrupt end to long standing traditions is perhaps surprising given the continued importance of tasks such as woodworking in people’s lives. But it is probably the result of developments in both the practical and symbolic importance of metal artefacts. Metal processing technologies and standards continued to develop during the course of the Early Bronze Age, as the manufacture and use of metal tools spread into new areas (Shalev 1992). Over time, these metal tools proved to be much more efficient than their flint counterparts, and were more highly valued. Beyond questions of access and the appearance of materials, metal artefacts were easier to maintain, repair and recycle, the latter potential creating the possibility that they are under-represented in the record that we have.

Discussion and conclusions

The procurement, use and deposition of stone and flint bifacial tools were central to the transition from hunting and gathering to agriculture, sedentary settlements, and to the social complexity which characterized the Neolithization process in the Southern Levant. They emerged in response to new needs, which were themselves related to important social, cultural and economic transitions at the time. As well as their function, they also linked symbolic elements with social situations, giving them new values as perceptions and belief systems developed. On the one hand, they were essential for the massive and intensive environmental exploitation that took place, especially during the Neolithic. That is at least part of the reason why their use lives were often prolonged, individual tools resharpemed, repaired and reworked over considerable periods of time (Barkai 1999). Many axes and adzes, that were no longer functional or repairable, were converted to cores, thus allowing continuing use of the raw material in new ways. On the other hand, these tools were also caught up in the playing out of social relations and in the struggle for power and renown in society. They were both production and reproduction. Archaeologically, the materials we recover sometimes speak more directly to questions of use and practicality, sometimes to issues of symbolism and ceremony. I have argued here that one of the important qualities possessed by many bifacial tools at this time was a categoric and symbolic association with maleness (see also Barkai 2005:68–70). This was sufficiently powerful that axes created a symbolic link between human fertility and the fertility of the land. Undoubtedly, with such significance, the axe was a prominent feature in socio-political discourse.

The practical and symbolic value of these tools was implicated in all aspects of their lives; from quarries and workshops to their placement in hoards and burials. Great efforts – translated, in modern terms, into high manufacturing costs – were invested in the procurement of such materials (Barkai 2005:6–9, Barkai et al. 2007). This alone suggests the perceived importance of these tools to their owners and to broader society. The location of stone and flint quarries and mines, typically at a distance from the occupation sites, points to a deliberate distribution system, and perhaps even to a complex exchange system, capable of explaining the movement of the raw materials and the finished products to their final destinations (Quintero 1996, Quintero and Wilke 1995, Schyle 2007). These mines and
quarries, along with certain workshops, were situated in conspicuous locations and became “scars” in the otherwise undisturbed landscape; used repeatedly by different generations.

Although axes, adzes and chisels were used to process wood, it is clear that each tool type had its specific functional purposes. Tranchet axes were used for light tasks but never for tree felling (Yerkes et al. 2003), tasks more often addressed with later Neolithic flint polished axes. However, axes were themselves only used in a certain number of activities. Adzes, in contrast, were much more versatile, capable of being deployed in a far wider range of tasks, including those delicate forms of working that also suited chisels. Their versatility may have been part of the reason they became so ubiquitous (Yerkes and Barkai 2004; 2007; forthcoming).

The manufacture of PPNA axes was an innovation which required a new flaking technology. It also involved the development of an entire system, including workshops for manufacturing and repair, which became part of each tool’s biography. Polished stone and basalt axes, which appeared for the first time in the PPNA, were also important cultural markers. Although polishing was a well-known technique, never before had it been applied to stone artefacts. These stone axes differ considerably from their flaked flint counterparts. Their large size, combined with the use of special raw materials and their polished appearance, gave them ritualistic and symbolic value. PPNA bifacial tools are the first group of tools to overtly fulfill two roles: functional and symbolic. Functional analysis of PPNA bifacial tools shows that this was only the beginning of a trend. Although humans were still learning how to modify their natural environment, the consequences of bifacial stone tools were apparent, and were embodiments of the respect, and possibly awe and wonder, given to the tools by their makers and owners.

The transition from PPNA to PPNB was marked by a gradual change in the way in which bifacial tools were made, used and perceived; there was a phase during which old techniques and new ones co-existed, while the one declined and the other matured. The most conspicuous change of the time was the extension of the polishing technique from overtly symbolic tools to those that saw sustained practical use. Polished PPNB axes are considerably larger, heavier and more efficient than the transverse flaked PPNA axes and it has been argued here that these practical characteristics; mass and efficiency, mattered a great deal at the time. The effectiveness of the PPNB axe helped to take the relationship between humans and the environment to a new level.

By the PN, the axe had become a most powerful functional and symbolic item in southern Levant culture. Its replacement by a more efficient tool, the adze, was a long and gradual one; a change that could only occur within a broader and more comprehensive process of cultural change. At the beginning of the PN, a new need had arisen: wood as fuel for the growing pottery industry. This need, along with the development of architecture, may have stimulated the production of adzes. All PN assemblages suggest a gradual transition, from the old familiar axe to the new adze, which was complete by the Chalcolithic. The adze was developed as part of an ongoing process of socio-economic and cultural change which, during the PN, had shifted towards a full dependency on agriculture and the domestication of livestock. Such an economy demanded a new social order, which, consequently, created political struggles and debates. It is no surprise, then, that the early PN’s symbolic assemblage is such a rich and varied one (e.g. Gopher 1995). At first glance, the development of the adze may seem like only a relatively minor change. In skilled hands, however, its versatility gave it a potential that earlier axes never realized, a potential that also encouraged its recognition as an important symbol.

Just as earlier axes had done, the adze persisted as an important tool and as a symbol for some time before those roles were finally taken on by metalwork and metalworking. These sequences of development were driven by many things. But ultimately, the need for resources and even the investment of time and effort in the making of axes and adzes was a consequence of the wealth economy. As the primary working instruments and as symbols deployed in exchange and display, they were intimately bound up in the complex and dynamic social systems of the Neolithic and Chalcolithic in Southern Levant.

In order to create and implement technological change, certain pre-conditions are necessary. These conditions are found typically when a social system is willing to accept innovations; to change the familiar for the unfamiliar. Typically, the adoption of such change also depends on effective social and political relationships. Thus, the technological changes that bifacial tools underwent suggest an openness-mindedness in the Neolithic and Chalcolithic societies of Southern Levant. These societies acknowledged that the new needs to be met.
because of their changing lifestyles, required a technological system that was continually and successfully responsive. These societies appeared to have been highly manipulative; capable of training their members to achieve specific community-focused goals; and creating ideological identities.

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